

*The Multicast Dissemination
Protocol version 2 (MDPv2) Toolkit*

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MDP Short History

- **Circa 1993:** Original Image Multicaster (IMM) MBONE application used for reliable file dissemination ^[1] of satellite weather and other imagery files across the worldwide Internet.
- **1995 - 1997:** Collaborative effort with NRL and U. of Hawaii to generalize and enhance the IMM protocol and software. Resulted in the Multicast Dissemination Protocol (MDP) Framework^[2]
 - demonstrated in operational satellite multicast networks, DARPA high speed simulation networks, and extensive testing across the worldwide Internet Mbone (100s of clients).
- **1997 - Present:** MDP version 2 protocol and software development to add advanced protocol techniques and provide a more generalized software implementation.
- MDPv2 tools and documentation available at:
<<http://manimac.itd.nrl.navy.mil/MDP>>

[1] - W. Dang, *Reliable File Transfer in the Multicast Domain*, White Paper, 1993

[2] - J. Macker, W. Dang, *The Multicast Dissemination Protocol Framework*, Internet Draft : draft-macker-mdp-framework-02.txt, 1996-97

MDPv1 Framework Features

- Efficient one-to-many and many-to-many reliable multicast dissemination
 - Selective negative acknowledgement (NACK) receiver-based protocol for scalability
 - NACK suppression to improve feedback implosion problem
 - Cyclic repairing and aggregation of control messaging
 - Optional positive receipts from selected receivers
- Demonstrated robust operation in high packet loss and heterogeneous network conditions
- On-demand or timed dissemination of file data or directories
- Good protocol properties for asymmetric and wireless network operation.

MDPv2 Protocol Enhancements

- NRL multicast packet *healing* mechanisms based upon FEC erasure codes [3,4]
- Improved group repair cycle efficiency based on robust, automated network timing estimations.
- Support for emission controlled, *silent* clients.
- Potential for supporting both non-real-time and real-time reliable and robust data *streaming*.
- Improved performance for asymmetric and wireless operation.
- Run-time tunable protocol parameters for adaptation to extreme network environments.

[3] - <http://tonnant.itd.nrl.navy.mil/ipresearch/rmfec/intfec/index.htm>

[4] -J.P. Macker, "Reliable Multicast Transport and Integrated Erasure-based Forward Error Correction",
In Proceedings IEEE MILCOM 97, Oct 1997

MDPv2 objects (e.g. files) are transmitted as a sequence of segments (packets) grouped into coding blocks ...
(The server calculates parity repair packets for each coding block)

Transmitted data ...

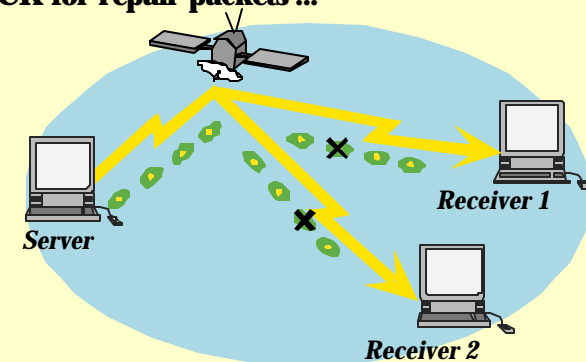


At coding block (or object) transition boundaries, receivers have an opportunity to NACK for repair packets ...

Receiver 1 (missing block 1, packet #3) ...

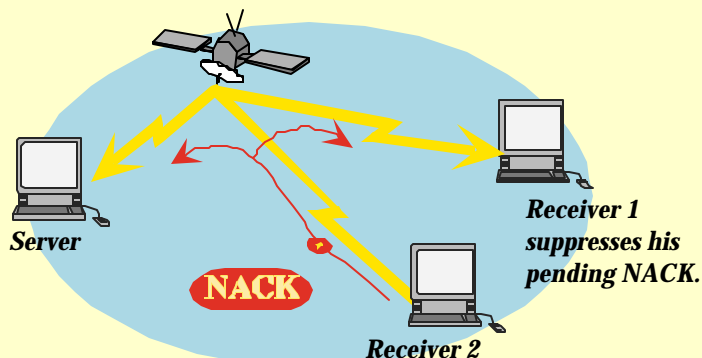


Receiver 2 (missing block 1, packet #2) ...

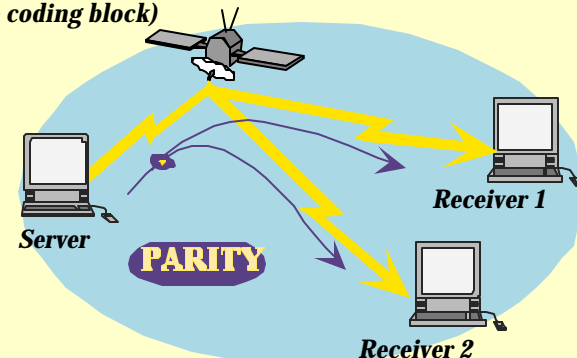


NACKs are transmitted by each receiver after a random backoff time based on group round trip packet delays collected by the server(s). Redundant NACK messages are suppressed among multicast receivers.

In this example, Receiver 2 NACKs first ...

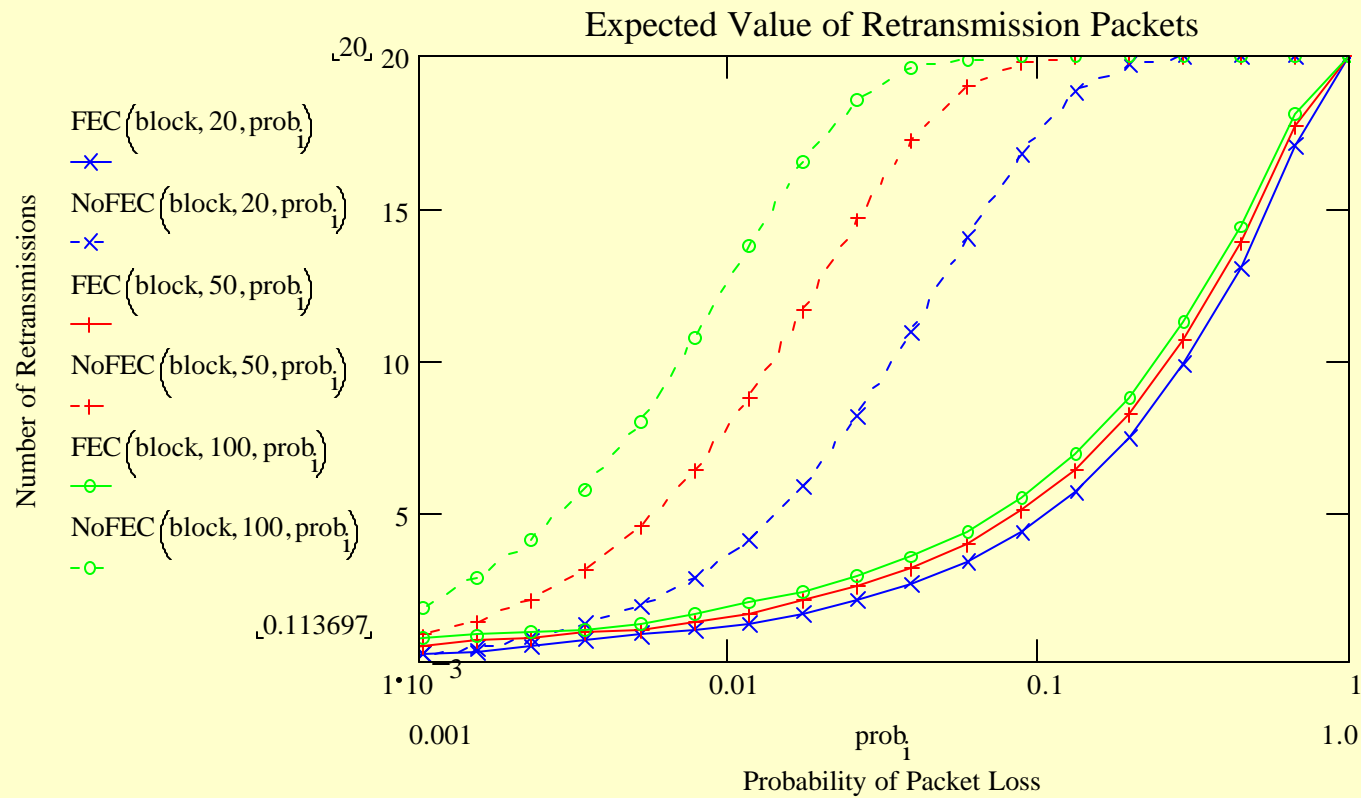


*The Server responds with appropriate parity repair packet(s).
(A single parity packet can repair _any_ single missing data packet for the coding block)*



Multiple repair cycles may be required to completely repair a block. Parity-based "packet healing" helps minimize required packet repairs.

Example Message Reduction



Block=20 packets, Group Sizes of 20, 50, 100

MDPv2 Present Status

- Client (receiver) and server (sender) applications available for most Unix and Windows (95/NT/98) platforms
- Flexible operating modes and post-processing options (e.g. group file/directory mirroring, multicast web push, etc)
- Conducting laboratory and *worldwide Internet* evaluations of protocol and software implementation
- Working with several external projects in deploying the software in demonstration and early operational capability settings.
- Creating an improved API to allow the MDPv2 protocol engine to be used in a more flexible fashion
- Ns-2 (Network Simulator) implementation for performance trade-off and congestion control studies.

MDPv2 Users

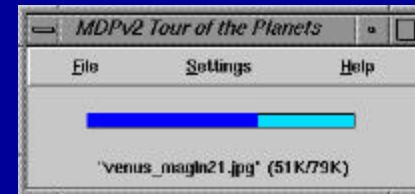
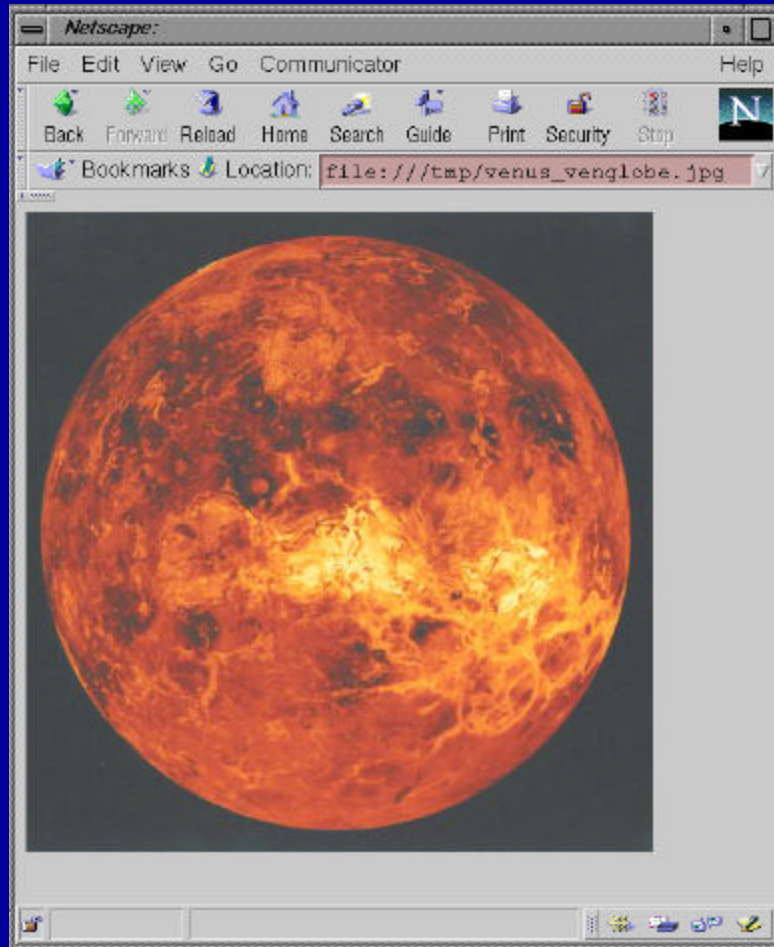
- JWID 98 over Direct Broadcast Satellite (2 Mbps forward channel with 2.4 kbps UHF TACSAT back channel).
- GCCS-M (MDP incorporated into COPS)
- Army FBCB2 (Field tested at EPG with 58 SINCGARS and EPLRS nodes)
- Nuclear Test Ban Treaty Organization
- Misc. others.

MDPv2 Application Options

- *Unicast feedback* for clients when reciprocal multicast routing is not sensible or possible
- *Silent* client mode (no feedback channel required)
- *Proof of receipt* to source from select clients.
- User definable post-processing of received files
- Temporary caching or permanent archiving of data content
- Numerous logging and statistics collection options
- Server parameters (e.g., block size, repair mode)
- Compatibility with UCL Session Directory (sdr) MBONE tool
 - the distributed “*Multicast Content Guide*” of the Internet Mbone
 - worldwide multicast session announcement, launching, and scheduling tool

MDPv2 “Web Push” Screenshot

(from the recent NRL MDPv2 Tour of the Planets MBONE Session)



MDPv2 Code Base Features

- High performance ANSI C++ implementation. (Gnu compilers, Microsoft Visual C++, Metrowerks CodeWarrior development platforms)
- Modular and extensible set of C++ classes. An opaque API has been developed.
- Designed to operate the protocol within memory bounds defined by developer/user.
- Designed to eventually be portable to different operating systems, embedded systems, protocol stacks (e.g. IPv6) or for kernel level implementation.
- Designed for 32-bit (or greater) processors but could be readily adapted to other architectures.
- *Everything* is parametric.

MDPv2 Future Directions

The MDPv2 toolkit project provides a flexible, open mechanism for the investigation and application of reliable multicast technology. Future planned work includes:

- Adaptive multicast congestion/flow control research
 - widely accepted multicast research problem (e.g., USC/HRL already integrated MDPv1)
 - allows MDPv2 rate adaptive applications to efficiently and fairly share bandwidth
 - target overall peaceful co-existence with unicast TCP applications
 - Very good initial results to date
- Proactive network congestion avoidance
 - MDPv2 with enhanced IP traffic management (enhanced queueing, RSVP, etc)
- Additional application level frameworks (streaming, proxying schemes, etc)
- Support for improved reliable end-to-end delay (Globecom 98 paper)
- Multicast security enhancements and applications
- Continued empirical and analytical evaluation within the worldwide Internet, Navy/DoD and other networks, and via simulation

For further MDPv2 information:



See the web site for the latest distribution and documentation:

[<http://manimac.itd.nrl.navy.mil/MDP>](http://manimac.itd.nrl.navy.mil/MDP)

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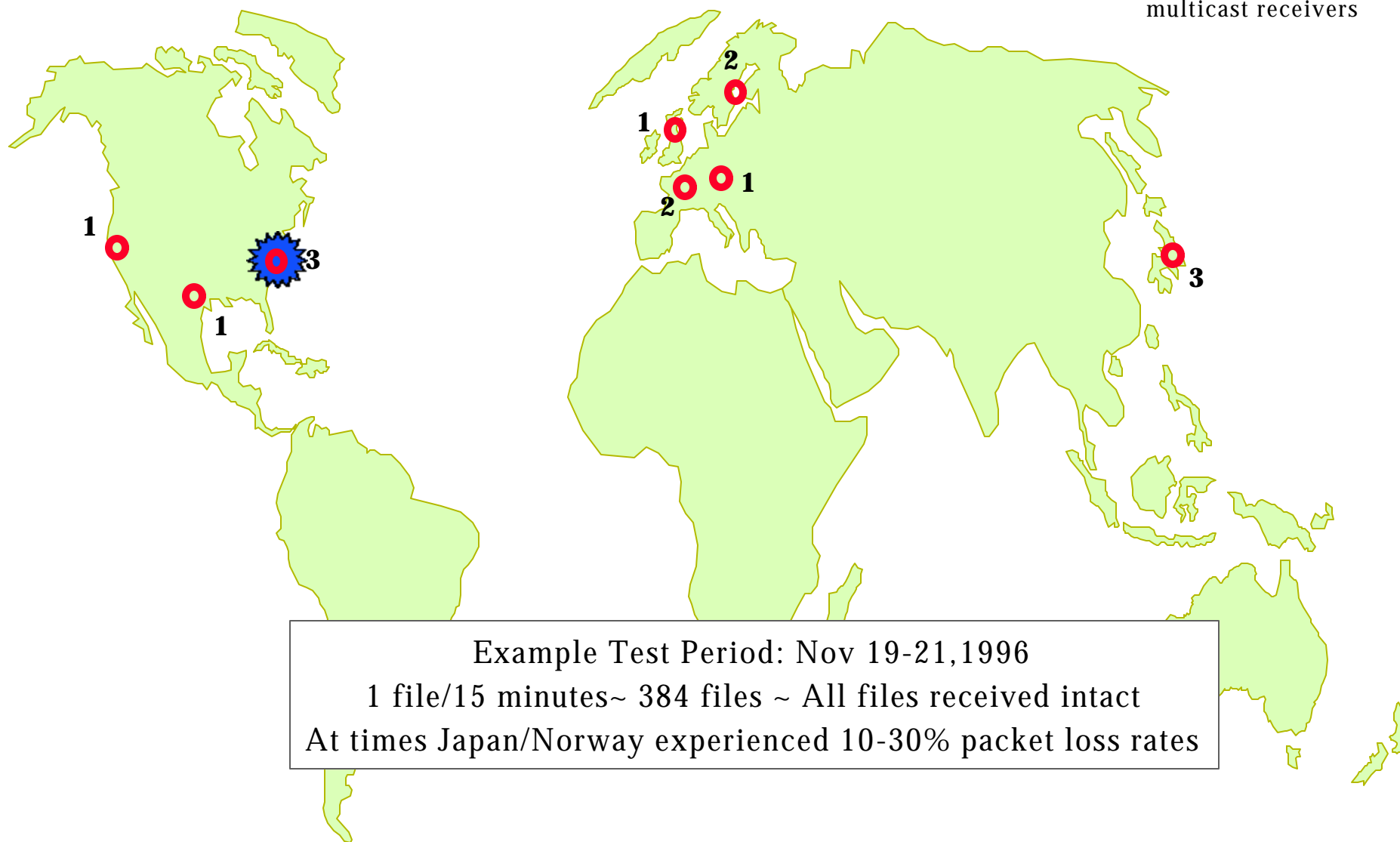
Have fun and try the software for yourself !!

Background Slides



IMM/MDP Use and Testing on the Global Internet

● = location and # of
multicast receivers



*tests have been done with >100 receivers simultaneously